Wet Detention Basin

Mary Anne Lowndes

DNR

Post-Construction Stormwater Management Workshops

November - December 2004

WISCONSIN
DEPT. OF NATURAL RESOURCES

Definition

- Permanent pool of water
- Design features
  - Inlets
  - Outlets
  - Storage Capacity

- Collect, detain, treat and release runoff

Site Assessment

- Conducted and documented
- 2-foot contour map
  - Location of basin, soil borings or test pits, buildings, wells, wetlands, navigable stream, roads, utilities, etc.
- Soil log
  - 3 feet below proposed bottom
  - Water table and bedrock if encountered

Permanent Pool

- Goal - 80% reduction of TSS
- Based on land use in drainage area
- Surface area determined by Table or Approved Model
  - For State - P8, SLAMM, or Equivalent
  - For Local - See local ordinances

Table 1 Calculation of Minimum Permanent Pool Surface Area

Land Use	Total Impervious (%)	Min. Area of Pool (% of watershed)
Residential		
< 2.0 units/acre (>1/2 acre lots)	8 - 28	0.7
2.0 - 6.0 units/acre (medium density)	> 28 -41	0.8
> 6.0 units/acre (high density)	> 41 - 68	1.0
Parks / Open Space / Woods / Cemeteries	0-12	0.6

Table 1 Calculation of Minimum Permanent Pool Surface Area

Land Use	Total Impervious (%)	Min. Area of Pool (% of watershed)
Office/ Inst./Warehouse		
	<60	1.6
	60-80	1.8
	>80	2.0
Commercial/Manufacturing/Storage		
	<60	1.8
	60-80	2.1
	>80	2.4

Example

- Impervious area varies with land use
- Impervious area includes
  - roofs, driveways, parking, sidewalks, roads
- Example Condition:
  - 60 acres of medium density (40% Imp.)
  - 10 acres of school (50% Imp.)
  - 20 acres of strip mall (85% Imp.)
  - 10 acres of park (5% Imp.)

Example continued

- Housing 60 X 0.008 = .5 acres
- School 10 X .016 = .2 acres
- Strip Mall 20 X .024 = .5 acres
- Park 10 X .006 = .1 acres
- Total 1.3 acres

- Permanent pool area - 1.3 acres

Permanent Pool Features

- Includes forebay and main pool
  - Minimum of 10,000 square feet
- Forebay:
  - At the inlet to trap larger particles (sand)
  - 3 feet deep plus storage depth
  - Storage depth based on maintenance plan
  - Surface area of forebay 5-15% of total permanent pool area

Permanent Pool Features

- Flow Path from inlet to outlet through forebay and main pool shall be 3:1 length to width or greater

Safety Shelf

- Safety shelf
  - 8 feet from
    edge of permanent pool
  - 10:1 slope or flatter
  - Maximum depth of 1.5 feet

Permanent Pool Features

Main Pool

- 3 feet average depth over storage volume to maintain quiescent settling
- 2 feet minimum depth for sediment storage (depends on maintenance plan)
- Total of 5 feet deep for 50% of main pool if basin is at least 20,000 sq. ft.

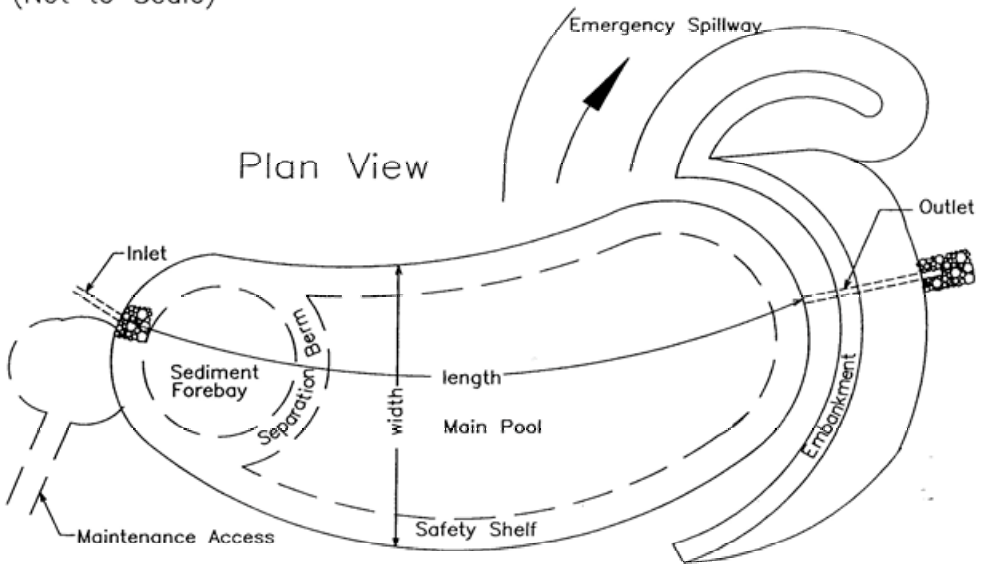
Permanent Pool Features

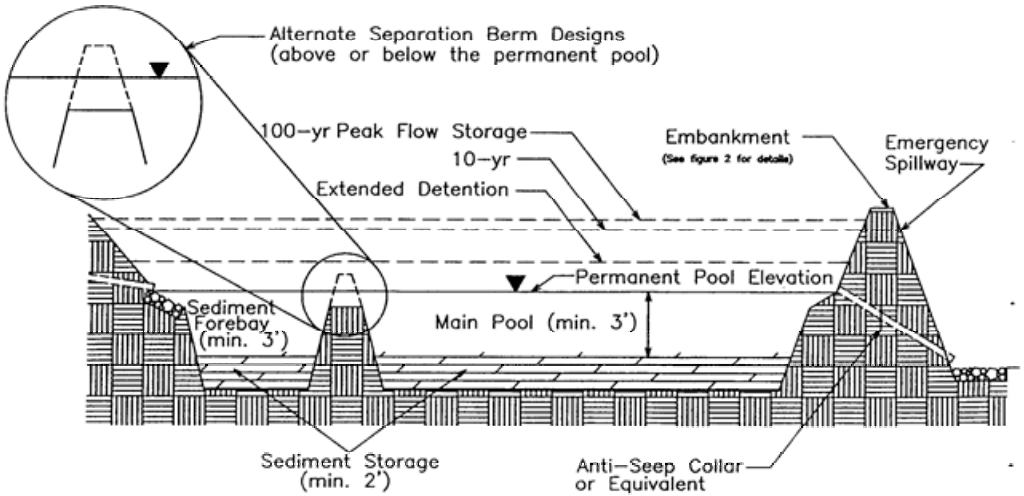
Main Pool

- Slopes
  - Below safety shelf: 2:1 or flatter for stability
  - Above safety shelf: 4:1 or flatter for maintenance

Figure 1: Conceptual Wet Detention Basin

(Not to Scale)





Cross Section

Permanent Pool

Active Storage

- Area above permanent pool for water quality during smaller storm events
- Volume to control is the 1 year - 24 hr design storm
- See Tables 4 and 5 for runoff depth
- OR Approved model

Active Storage

- Volume to control is the 1 year - 24 hr design storm.
- Use TP-40 with Type II distribution
  - From TR-55 (NRCS)
- Propose also allowing use of Bulletin 71 Rain Fall Frequency Atlas of Midwest with Huff Distribution

Active Storage

- Outlet - Currently using “discharge over 24 hours”
  - Propose removing hour limitation and using settling velocity of 5 micron particle.
  - The velocity to settle 5 micron particle size using Stoke’s Law with SG = 2.5 and 10 degrees C is **5.12 X 10^{-5} ft/sec**.
- Control the 5 micron = 80% TSS control

Active Storage

Example:

$$Q_{outflow} = V_s * SA$$

- V_s (settling velocity) = 5.12 X 10^{-5} ft/sec
- From our example SA equals 1.3 acres or 56,628 square feet

- Therefore:
  - $Q_{outflow}$ for the pond would equal ***2.90 cfs***.

Peak Flow Control

- 2 year-24 hour control in standard and in NR 151
- 10 year-24 hour required in standard and maybe locally
- 25 to 100 year control as required locally
- Multiple outlet structure required.

Update of CN from NR 151

Table 2 - Maximum Pre-Development Runoff Curve Numbers for Cropland Areas

Hydrologic Soil Group	A	B	C	D
Runoff Curve Number	55	68	77	80
New Runoff CN	**56**	**70**	**79**	**83**

Local ordinances may require lower numbers.

Inlets

- Designed for 10 year -24 hour storm
- Non-erosive peak flow
- Extend riprap or liner 1.5 feet below permanent pool elevation

Outlets

- Multiple controls required for:
  - Active storage
  - 2 year - 24 hour peak flow control
  - Additional peak flow control (10, 25?)
  - Emergency spillway
    - One foot of freeboard above spillway
- Discharge to stable flow channel

Multi-Stage Outlet

Standard doesn't dictate outlet design.

V-notch Weir

Weir Structure

Riser Outlet

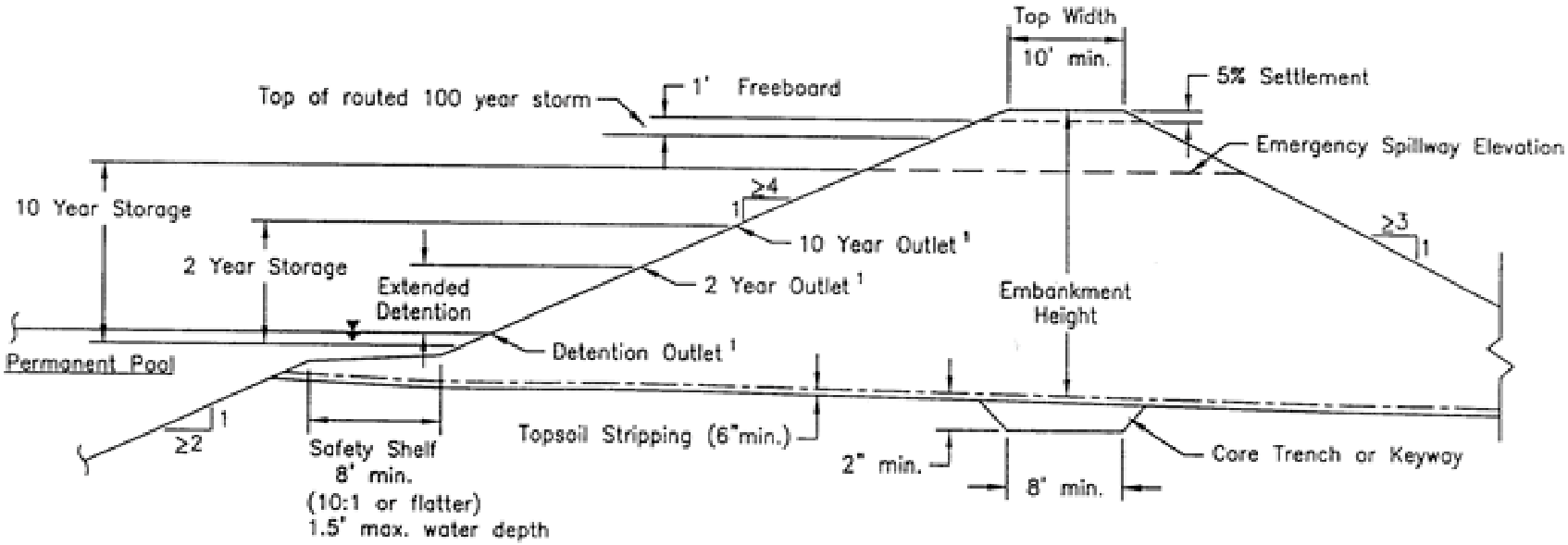
Embankment

- Earthen embankments
  - Designed to avoid seepage or saturation that may result in failure
  - Use only compacted, non-organic soils
  - Strip vegetation from base
  - Account for settling

Embankment

- May need key-way or core trench
- Pipes through embankments shall be bedded and back-filled with embankment or similar material.
- Use anti-seep collars or sand diaphragms.
- Side slopes - 3:1 (or flatter for mowing)
- Top width of 10 feet for access

Figure 2: Typical Embankment Cross Section for Wet Detention Basin (Not to Scale)



1. These are conceptual outlet locations to indicate the need to have different outlets for different purposes. Numerous outlet designs will meet the criteria of the standard.

Proposed Liners

- If soil is more permeable than a saturated hydraulic conductivity of 1×10^{-5} cm/sec, then a liner is needed to maintain a permanent pool.

- Examples: coarse sand and gravel

Proposed Liners

- If soil is tighter than a saturated hydraulic conductivity of 1 X 10^{-7} cm/sec, then no liner is needed.

- Examples: sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, or clay

Proposed Liners

- Between 1 X 10^{-5} and 1 X 10^{-7} cm/sec, conduct a risk analysis for:
  - Source of pollutants (Tier 1 industries, some Tier 2 industries, fueling and maintenance areas)
  - Depth to groundwater and bedrock (5 feet)
  - Proximity to community (400 feet) or private wells (100 feet).

Liner Material

Liner material can be soil, soil-bentonite, or synthetic.

Clay liner

Water Quality Models

- Models can be used in place of technical standard for pollutant reduction, peak flow control.
- Model approved by regulatory authority.
- Approved model must be able to calculate pollutant loadings and reductions by BMPs.

Water Quality Models

- WinSLAMM and P-8 are not designed to route or evaluate peak flow reductions.
- Pondpack, HydroCAD, TR-20, HEC-1, HEC-HMS, SWMM are common tools used to route and evaluate peak flows however these tools are unable to evaluate BMPs pollutant reduction.

Aerators

Pollutant reduction based on quiescent settling in the pond. Aerators mix the pond contents and disrupt settling.

Regional Treatment

- Regional ponds are given credit under NR 151 if:
  - They are not “in” a navigable stream
    - No backwash from 10-year event or less
    - Outside the lateral extent (OHWM to OHWM)
  - They are constructed prior to receiving flows from the development.
  - They are designed to handle flows from the development and other contributory areas.

Considerations

- May need to add other BMPs if temperature, oxygen depletion, toxins or nutrients are a concern.
- Ponds in series need to track particle size.
- Aesthetics.
- Stabilize drainage area to minimize sediment delivery.

Operation and Maintenance

- Plan should address:
  - Removal and disposal of litter, floating materials, materials clogging inlets or outlets.
  - Regular maintenance of vegetated areas such as mowing and removal of nuisance vegetation.

Operation and Maintenance

- Repair of eroded areas.
- Removal of sediment.
- Repair to inlets and outlets.

Other Ponds in Standard

- Construction Site Pond
  - Conversion from construction to post-construction
  - Permanent pool size should be equal to or larger than post-construction pond
- Agricultural Wet pond
  - Additional features for control of agricultural watershed

Questions?